Study of Atmospheric Pollution due to Vehicular Exhaust at the Busy Cross Roads in Peshawar City (Pakistan) and its Minimizing Measures

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Summary: Studies on the atmospheric pollution caused due to vehicular exhaust at the busy cross roads in the Peshawar city were carried out. The major gaseous air pollutants *i.e.* carbon monoxide, nitrogen oxides, sulphur dioxide and hydrocarbon levels during 0700 to 1900 hrs were studied at 10 different locations of Peshawar city with maximum traffic density. Nine out of ten locations were having average carbon monoxide levels above the permissible National Ambient Air Quality Standards (NAAQS). The carbon monoxide level ranged between 9 and 24 ppm, whereas its permissible level is 09 ppm. Similarly nitrogen oxides levels were found higher than the NAAQS of 0.15 ppm at all the sites. The nitrogen oxides level ranged between 1.7 and 3.5 ppm. With the exception of General Bus Stand, there is no indication of sulphur dioxide in rest of the locations studied. The concentration of hydrocarbons was found to be negligible in the studies undertaken. On the basis of these studies, it has been concluded that the higher levels of carbon monoxide and nitrogen oxides in the ambient air cause deleterious impacts on the human health. Recommendations and suggestions to minimize the harmful effects of the gaseous pollutants due to vehicular exhaust are also described.

Introduction

Air pollution means the presence in the outdoor atmosphere of one or more contaminants such as dust, fumes, gases, mist, odour, smoke or vapors in quantities, characteristics and of duration which may be injurious to humans, plant or animal life or to property or which unreasonably interferes with the comfortable enjoyment of life and property [1]. Air is never found absolutely clean in natural occurrences such as; volcanic activities, forest fires, vegetation decay and anthropogenic activities which cause increase in the concentration of pollutants like CO, CO_2, SO_x, H_2S, NO_x and hydrocarbons (HC) continuously to air around us [2].

The major contributors to air pollution are vehicular traffic and rapid industrialization. With an improved standard of living and increased demand on the transport sector, automobile related pollution is fast growing into a problem of serious dimension in Peshawar city.

Traffic introduces dust, soot, carbon dioxide, carbon monoxide sulphur dioxide, oxides of nitrogen, hydrocarbons into the air [3]. There are about 250,000 registered and hundreds of unregistered motor vehicle plying on the roads of Peshawar discharging toxic gases into the atmosphere.

Carbon monoxide is one of the most common and very toxic gaseous pollutant which can seriously affect human aerobic metabolism owing to its high affinity [4] for haemoglobin, the component of blood responsible for the transport of oxygen. Longer persistence of this pollutant as estimated by Peavy *et al.*, [5] in the air makes it more dangerous for the human beings. Atmospheric pollution due to Carbon monoxide from vehicular exhaust in Peshawar was also studied by A. R. Khan *et al.*, [6], who has reported that the concentration of carbon monoxide reached the limit of 35 ppm for one-hour average exposure.

The common sources of oxides of nitrogen are automobile exhaust, gas stoves and heaters, wood burning stoves and kerosene spaced heaters. Short-term exposure of NO_2 has been linked with an increased susceptibility to acute respiratory infections, increased airway resistance in Asthmatics and decreased pulmonary function, cough and sore throat [7]. Long-term exposure results in Emphysematous-like lung changes. Extra-pulmonary changes include changes in body weight, blood cell count and liver enzymes.

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Sulphur dioxide (SO_2) results from combustion of sulphur containing fossil fuels, smelting of sulphur containing ores and other industrial processes. The most striking response is rapid broncho constriction [8]. Acidic aerosols resulting from SO_2 are linked with production and exacerbation of asthma and chronic bronchitis.

The main sources of hydrocarbons include automobile exhaust, incineration, combustion of coal wood and cigarette smoking. They are linked with different cancers. National Conservation Strategy (NCS) says that an average Pakistani vehicle emits 20 times as many hydrocarbons as compared with a US vehicle [9].

Air pollution levels in Pakistan's most populated cities are among the highest in the world and climbing, causing serious health issues. The levels of ambient particulates smoke particles and dust, which cause respiratory disease are generally twice the world average and more than five times as high as in industrial countries and Latin America [10].

The present study was aimed at to obtain base line data of different air pollutants for selected areas in Peshawar and to assess their effects on the human health. The present studies were also compared with the previously repored studies carried out by A. R. Khan [6] where the carbon monoxide level was measured at 16 different locations in Peshawar city. In the preset study, the carbon level has been found to be higher in almost all the locations than the permissible level whereas in the previous studies 12 out of 16 locations have an average CO level above the threshold limit of 9 ppm. The data obtained as a result of these studies could be used for implementtation of appropriate measures against the hazardous effects of air pollution.

Results and Discussions

Transportation density is increasing day by day worldwide and is more in the urban areas than in the rural areas. This increase is directly related to the increase in the roadside atmospheric pollution. Ten different road cross sections with high traffic mobility were selected to present a representative atmospheric study of Peshawar city. The different road cross-sections/chowks, studied are shown in Table-1.

The average CO in the ambient air at 10 major cross roads in Peshawar ranged between 9 and 24 ppm, the concentration being highest at Kabli chowk (24 ppm), shown in Table-2. The NO_x concentration at 10 major cross roads in Peshawar ranged between 1.70 and 3.50 ppm, highest being at Hashthnagri chowk having 3.50 ppm NO, indicated in Table-3. Maximum traffic mobility was noted at Hashthnagri chowk having 10480 vehicles passing per hour, presented in Table-7. The air analyses also show that the concentration of CO, SO_2 and NO_x were comparatively high in the dense traffic roads and

Table-1: Locations of road cross sections in Peshawar and their abbreviation

Sr. #	Road Cross sections/Chowks	Abbreviations used
1.	Board chowk	BC
2.	Speen Jumat chowk	SJC
3.	Arbab Road chowk	ARC
4.	Stadium chowk	StC
5.	Dabgari chowk	DC
6.	Shoba chowk	SC
7.	Kabli chowk	KC
8.	Bacha khan chowk	BKC
9.	Hashthnagri chowk	HC
10.	General Bus stand chowk	GBSC

Table-2: Concentration of Carbon Monoxide at different cross sections in Peshawar

Sr. #	Road Cross sections/ Chowks	Concentration (ppm) 8:00 A.M. to 12 Noon	12 to 04:00 P.M.	4:00 to 8:00 P.M.	Median	Maximum*
1.	BC	8.5	12	10	10	30
2.	SJC	11	11	13	11	34
3.	ARC	13	9	7	9	18
4.	StC	2	16	10	10	25
5.	DC	21	18	30	21	39
6.	SC	22	17	18	18	28
7.	KC	24	22	50	24	59
8.	BKC	21	17	20	17	43
9.	HC	15	16	18	16	27
10.	GBSC	16	19	15	16	47

* For transient period during traffic jams and congestion

Table-3: Concentration of Oxides of Nitrogen at different cross sections in Peshawar

Sr. #	Road Cross sections/ Chowks	Concentration (ppm) 8:00 A.M. to 12 Noon	12 to 04:00 P.M.	4:00 to 8:00 P.M.	Median	Maximum*
1.	BC	1	1.7	2.0	1.70	5.8
2.	SJC	1.75	2	1.5	1.75	3
3.	ARC	1.2	2.0	1.9	1.90	2.5
4.	StC	1.6	2.5	2.8	2.50	3.2
5.	DC	2.6	3.0	2.5	2.60	3.2
6.	SC	2.0	3.0	3.0	3.00	3.5
7.	KC	1.9	3.2	2.9	2.90	3.8
8.	BKC	2.0	3.0	3.0	3.00	3.9
9.	HC	2.6	3.6	3.5	3.50	4.0
10.	GBSC	3.0	3.5	3.0	3.00	3.7

* For transient period during traffic jams and congestion

decreases as we move away from the busy roads [11, 12].

With the exception of the General Bus Stand (GBS), the SO_2 was not detected in other localities. At GBS where the traffic mobility is at the highest, it varies from 0-0.38 ppm as shown in Table-4 which is higher than the permissible level of 0.35 ppm. Hydrocarbon was also part of the study but it was not detected as its concentration was below the detection level of the sensor.

The Kabli chowk and dabgari chowk have higher levels of CO and NO_x. as indicated in Table-2, their values are 24 and 2.9 ppm and 21 and 2.6 ppm, respectively. The moderately high levels of CO and NO_x were indicated at shoba chowk having CO (18 ppm) and NO_x (3.0 ppm), Bacha Khan Chowk having CO (17 ppm) and NO_x (3.0 ppm), Hashtnagri Chowk with CO (16 ppm) and NO_x (3.5 ppm). The General Bus Stand has CO (16 ppm) and NO_x (3.0 ppm). The high levels of CO and NO_x are probably related to the increased traffic mobility in these areas, as shown in Table-7.

Intersections with slightly high levels of CO and NO_x are Speen Jumat Chowk (CO = 11 ppm, NO_x = 1.75 ppm), Stadium chowk (CO = 10 ppm, NO_x = 2.5 ppm), Board chowk (CO = 10 ppm, NO_x = 1.7 ppm) and Arbab Road Chowk (CO = 9 ppm, NO_x = 1.9 ppm).

The present studies suggested that the most important factors contributing to air pollution are narrow roads, increased traffic mobility, slow moving traffic and multi-storey buildings constructed close to the roads. Other less important factors are condition of the faulty engines, quality of fuel used and combustion of waste materials at roadsides

Experimental

Data regarding concentration of different air pollutants was collected employing different sensors. The sensor used for carbon monoxide was GC401 made by Metronic's Inc., USA. Its range of measurement is 0 to 1999 ppm. The sensor used for oxides of nitrogen, sulphur dioxide and methane (Hydrocarbons) was Triple Plus + made by Crowcon Detection Instruments Ltd., Oxford shire, United Kingdom. Three readings were taken at each cross road, three times a day i.e. morning, noon and evening for half an hour. The sensors were placed at an appropriate

Table-4: Concentration of Sulphur dioxide at different cross sections in Peshawar

Sr. #	Road Cross sections/ Chowks	Concentration (ppm) 8:00 A.M. to 12 Noon	12 to 04:00 P.M.	4:00 to 8:00 P.M.	Median	Maximum*
1.	BC	0	0	0	0	0
2.	SJC	0	0	0	0	0
3.	ARC	0	0	0	0	0
4.	StC	0	0	0	0	0
5.	DC	0	0	0	0	0
6.	SC	0	0	0	0	0
7.	KC	0	0	0	0	0
8.	BKC	0	0	0	0	0
9.	HC	0	0	0	0	0
10.	GBSC	0.33	0.38	0	0.33	0.38

* For transient period during traffic jams and congestion

Table-5: National Ambient Air quality standards (NAAQS) for gaseous pollutants

Pollutants	Time span	U.S. Standards	W.H.O. Standards
CO	1hr	40mg/m^3	30 mg/m^3
	8hr	10mg/m^3	10mg/m^3
NO_x	24hr	100 μg/m^3	150 μg/m^3
SO_2	1hr	365 μg/m^3	350 μg/m^3

Table-6: Concentration of Temperature at different cross sections in Peshawar

Sr. #	Road Cross sections/Chowks	Temperature (°C) Morning	Noon	Evening	Mean
1.	BC	29	39	35	34
2.	SJC	31	40	35	35
3.	ARC	29	39	34	34
4.	StC	28	39	33	33
5.	DC	30	40	32	34
6.	SC	28	39	33	33
7.	KC	30	41	32	34
8.	BKC	31	39	36	35
9.	HC	33	41	36	37
10.	GBSC	32	42	34	36

Table-7: Traffic Mobility at Different Cross Sections in Peshawar

Sr. #	Road Cross sections/ Chowks	Traffic Mobility Morning	Noon	Evening	Mean
1.	BC	6360	8760	4080	6400
2.	SJC	8400	7800	4800	7000
3.	ARC	7680	8040	5640	7120
4.	StC	2640	4020	2640	3100
5.	DC	2700	2220	2880	2600
6.	SC	4200	4560	4560	4440
7.	KC	4320	2160	1950	2810
8.	BKC	5400	4540	4680	4873
9.	HC	13320	10380	7740	10480
10.	GBSC	5640	5740	7200	6193

height for recording the results on the display of instrument. The traffic mobility and temperature were also recorded simultaneously.

The data was generated and presented in the form of tables. Median was used as the measure of Central Tendency for the data regarding gas concentrations. All the experimental results were compared with the U.S. and W.H.O. standards [13].

Conclusions

It is concluded from the studies undertaken that Peshawar city is badly polluted by Carbon monoxide and Oxides of Nitrogen, mainly emitted by automobiles, which severely affect the health of the people. Throughout the Urban areas motor vehicles are the major source of air pollution. Cars, trucks, buses and auto rickshaws contribute to air pollution by emitting Carbon monoxide, Oxides of Nitrogen, Hydrocarbons, Lead and Particulate Matter. Gasoline powered vehicles are responsible for the deteriorating situation of air pollution in Peshawar. There is a dire need to keep the vehicles tuned and vehicles with faulty and worn out engines should be removed from the roads. Avoiding traffic jams and removing the encroachments by shopkeepers and vendors can minimize the problem. Extensive plantation, use of Lead free gasoline, conversion of vehicles to CNG and compliance with all applicable regulations will help in reducing the menace of pollution in Peshawar.

Most of the people are aware of the hazardous impacts of air pollution but more individual or collective preventive measures and campaigns against air pollution are still needed.

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